~~APPARATUS AND METHOD FOR PASSIVE AND ACTIVE HAND AND FINGER EXERCISE~~

AN APPARATUS AND METHOD FOR INVOLUNTARY-REFLECTORY THERAPEUTIC EXERCISES

## ~~BACKGROUND OF THE INVENTION~~

**~~[0001]~~** ~~This invention relates to an apparatus and method for passive and active hand and finger exercise, particularly for development of the functions of hands and fingers and of sensory faculties, and for stimulation of neuropsychic and speech development in children suffering from infantile cerebral paralysis.~~

**~~[0002]~~** ~~An apparatus for passive and active hand and finger exercise, comprising a container and massaging elements in the container, is known. See, for example, USSR Author's Certificate No. 1537250 published January 23, 1990. In this apparatus the massaging elements are particles made of electrifying materials, such as copper, zinc, ebonite, etc. When using this apparatus during physical exercise, the particles contact the hand and carry out physical and electrical stimulation of biologically active points.~~

**~~[0003]~~** ~~Another apparatus for passive and active exercise of the hands and fingers is disclosed in G.V. Dedyukhina, L.D. Mogutchaya, T.A. Yanshina, "Logopedic massage and therapeutic physical training for 3-5 year old children, suffering from infantile cerebral paralysis," M., "Gnom-Press," 1999, p.17. This apparatus comprises a container and working elements freely placed in the interior space of the container. The working elements are peas or kidney beans. A patient exercises by immersing the hands in the mass of working elements or rolling the working elements between the palms of the hands. In this manner the muscles of the hand are massaged. Finger exercises, such as selecting and removing individual working elements and distributing the working elements according to size, help activate motor functions of~~

the hands, manipulation skills, and small motor functions. Massage and exercise with this apparatus are not satisfactory because they do not influence the biologically active points to a significant degree. The working elements, being practically uniform in size, shape and color, do not affect the psychoemotional status of the child and do not favor teaching through play. Accordingly the apparatus has only a small influence on medical factors. Further, since the working elements are small, use of the apparatus with children of 6-7 years or younger is not advisable due to the danger of swallowing or penetration into a respiratory passage or the ear.

## SUMMARY OF THE INVENTION

**[0004]** In accordance with a first aspect of the invention there is provided a therapy apparatus comprising a container having an interior volume and having an opening providing access to said interior volume, and a plurality of massaging elements freely located in the interior volume of the container, wherein each massaging element has a generally spherical exterior and has a plurality of protrusions projecting from said generally spherical exterior, whereby a patient who inserts his hand into the container through the opening and moves his fingers among the plurality of massaging elements is stimulated by massaging elements contacting his fingers both at the front and at the back of the hand.

**[0005]** In accordance with a second aspect of the invention there is provided a method of administering therapy comprising providing a container having an interior volume and having an opening providing access to said interior volume, there being a plurality of massaging elements freely located in the interior volume of the container, wherein each massaging element has a generally spherical exterior and has a plurality of protrusions projecting from said generally spherical exterior, and instructing a patient to insert his hand into the container

through the opening and move his fingers among the plurality of massaging elements, whereby the patient's fingers are stimulated by massaging elements contacting the fingers both at the front and at the back of the hand.

**[0006]** In accordance with a third aspect of the invention there is provided a massaging element having a generally spherical exterior and a plurality of substantially conical protrusions projecting from said generally spherical exterior, wherein the locations of the protrusions are selected by a method that comprises inscribing a spherical surface with a polyhedron composed of a plurality of regular polygons each having a center and multiple vertices, each vertex being common to exactly three polygons, and mapping the centers and the vertices of the polygons from the polyhedron onto the generally spherical exterior of the massaging element.

**[0007]** The present invention may be used to stimulate or develop many kinds of grasping or gripping actions, such as holding a massaging element in the palm of the hand, wrapping a finger around the massaging element, and holding the massaging element by the tips of the fingers.

**[0008]** The present invention may be used to provide an apparatus and method for passive and active hand and finger exercise, permitting point massage of the hand, particularly the hand of a child, and drawing the psychoemotional sphere of a patient into a medical or rehabilitational process, enriching or intensifying the therapeutic effect of the massaging elements and heightening the therapeutic effect and widening the field of use of the apparatus.

## BRIEF DESCRIPTION OF THE DRAWINGS

**[0009]** For a better understanding of the invention, and to show how the same may be carried into effect, reference will now be made, by way of example, to the accompanying drawings, in which

FIG. 1 is a perspective view of apparatus embodying

the present invention,

FIG. 2 is an elevational view of a massaging element,

FIG. 3 is a sectional view of the massaging element,

FIG. 4 is another sectional view of the massaging element,

FIG. 5 is a sectional view of a second massaging element,

FIG. 6 is an elevational view of the second massaging element,

FIG. 7 illustrates a set of massaging elements of different size and color,

FIG. 8 is a sectional view of a third massaging element,

FIG. 9 illustrates a sphere inscribed with a polyhedron, and

FIG. 10 illustrates a massaging element embodying the present invention.

## DETAILED DESCRIPTION

**[0010]** FIG. 1 illustrates a container 1 having generally vertical walls and a rectangular, horizontal base. The container is made of a tough, transparent, chemically resistant, waterproof material such as polypropylene and has a lid or cover 15 of the same or a similar material. In the event that the mouth of the container is circular, the cover may be threaded to allow the cover to seal the container.

**[0011]** Inside the container are multiple massaging elements 2. The massaging elements are freely located in the container, so that they can be moved around in the container by finger pressure. The bottom of the container may have recesses (not shown) for locating the massaging elements. Each massaging element has a generally spherical exterior surface. Conical massaging protrusions or lugs 3 project from the spherical exterior surface.

**[0012]** The massaging elements 2 are in three sets, although

there may be more than three sets. Each set consists of seven or eight massaging elements. One set of seven massaging elements is shown in FIG. 7. The different massaging elements in a set are of different colors. The different colors may be the principal colors of the rainbow, and one of the massaging elements may be white. The different massaging elements in a set are of different respective sizes. The range of sizes is chosen on the basis of the hand structure and age of the patients. For patients aged from 3-7 years, the diameter of the smallest massaging element in a set may be 23-27 mm and the diameter of the largest massaging element in the set may be 35-40 mm. In another embodiment, the massaging elements of a given set are all the same size, and different sets are of different respective sizes. The massaging elements of the smallest set may be 23 mm in diameter, the elements of the next set may be 25 mm in diameter, the elements of the third set may be 27 mm in diameter, and so on.

**[0013]** The massaging elements may be solid and made of material having a Shore hardness number from 5-95, preferably from 40-75. Suitable materials include synthetic polymer materials, such as polystyrene, and wood. The massaging elements may be made of an electrifying material, i.e. a material on which an electrostatic charge can be induced, such as ebonite. The massaging protrusions must be sufficiently hard to provide the desired stimulation.

**[0014]** In another embodiment the massaging elements are hollow and are each assembled from two hollow hemispheres, as shown in FIG. 3. The two hemispheres are attached by mating hollow cylindrical fastening elements 5, 6 provided with interengaging latching members 4 that snap together and prevent separation of the hollow hemispheres. The two hemispheres are urged apart (within the limits of the latching members) by a compression spring 8 that is accommodated in the interior of the massaging element. The interaction of the mating fastening elements 6 and 5 allows relative rotation of the two

hemispheres. FIG. 3 shows the two hemispheres when they have been squeezed together, for example by gripping between finger and thumb, and FIG. 4 shows the two hemispheres when no external force is applied and they are pushed apart by the force of the compression spring 8. In the case of FIGS. 3 and 4 the compression spring is a coil spring. In another embodiment, the compression spring may be made of a resilient material such as rubber.

**[0015]** FIG. 5 shows a cartridge 9 within the hollow massaging element. The cartridge 9 may contain another active element, such as a magnet, a sound producing element (e.g. a bell), or an aroma source having the fragrance of lemon or pine, or a heat-emitting or heat-absorbing element, for example.

**[0016]** FIG. 6 shows a region 16 of the surface of the massaging element that is generally flat, i.e. without massaging protrusions, and the massaging element has a second such region that is diametrically opposed to the region 16 shown in FIG. 6. The flat regions are large enough to allow the patient to grasp the massaging element between, for example, the tips of the thumb and middle finger without pressing against a massaging protrusion, which may be helpful in developing fine finger motor skills. As shown in FIG. 6, a flat region may be provided with a label 16 that indicates the nature of the contents of the cartridge 9 in that particular massaging element. For example, the label 16 shown in FIG. 6 displays the letter N to indicate that the massaging element contains a magnetic active element oriented with its north pole towards the label 16.

**[0017]** FIG. 8 illustrates another embodiment in which the two hemispheres are attached by mating hollow cylindrical fastening elements 10, 11 provided with interengaging latching members 12. One of the hemispheres 7 has a peripheral sleeve 14 that receives the rim 13 of the other hemisphere. The interaction of the mating fastening elements 10 and 11 allows

relative rotation of the two hemispheres. The compression spring 8 surrounds the cylindrical fastening elements 10, 11 and the cartridge 9 is located within the inner fastening element 11.

**[0018]** In the case of FIGS. 2-5 and 8, the height h of the massaging protrusions is in the range 3-5 mm, and is preferably 4 mm. The tips of adjacent massaging elements are spaced apart at distance b in the range 3-8 mm, the preferred spacing, based on the distance between nerve ends (biologically active points) on the palm of the hand, being 6 mm.

**[0019]** In the case of FIG. 6, most of the massaging protrusions are of height h in the range 3-5 mm, and some of the protrusions are of height H, which is 1.5 to 2.6 times the height h of the majority of the protrusions. The taller protrusions are grouped together, as can be seen in FIG. 6. Including taller protrusions among the shorter protrusions provides a variation in massaging force as the massaging element rolls over the surface of the patient's hand, thus enhancing the effectiveness of the massage. The dimensions of the massaging protrusions are chosen based on safety and in order to maximize the influence on biologically active points.

**[0020]** The apparatus described with reference to FIG. 1 is particularly useful for rehabilitation after hand injuries, but it may also be used for other purposes, such as speech therapy. It has been found that particular sets of massaging elements are helpful in treating particular conditions. For example, for treatment of hand injuries it has been found that massaging elements containing magnetic active elements are useful. Specifically, for rehabilitation after a hand injury it is preferred to use six sets of massaging elements each comprising four elements, namely three blue elements 30 mm in diameter with no active element and one red element 40 mm in diameter with a magnetic element. For treatment of speech defects it is preferred to use two sets of massaging elements, each set comprising two yellow elements 25 mm in diameter with no active

element, one orange element 25 mm in diameter with no active element, two pink elements 25 mm in diameter with a sound-emitting element, e.g. a bell, and one green element 25 mm in diameter with no active element.

**[0021]** The apparatus described with reference to FIG. 1 may be used for individual and group studies. For example, a child immersing the fingers of one or both hands into the container 1 may execute different exercises, such as squeezing the fingers together and forcing the fingers apart, bending and straightening the fingers, sorting the massaging elements, and rolling the massaging elements along the palm or the back of the hand. In addition to the exercise of the fingers and general massage effect of these activities, the massaging protrusions apply a local influence to biologically active points. Since the distance between the points of adjacent massaging protrusions corresponds to the distance between nerve receptors (biologically active points) in the palm of the hand, the massaging protrusions stimulate the nerve receptors. Providing massaging protrusions of different heights intensifies the therapeutic effectiveness of the massaging elements, because the level of stimulation by the massaging protrusions is not uniform and the biologically active points are influenced.

**[0022]** A therapist may use the apparatus to conduct therapy by play. For example, in a group where several patients each have a container with several sets of massaging elements, the therapist might ask the patients to locate and remove three red massaging elements, or one small massaging element and two large massaging elements. In this way, the patient learns counting, colors and manipulation. It is particularly important in the case of group therapy that the container be transparent, so that the therapist can observe the activities of the patients, and made of chemically resistant material, so that the container and its contents can be washed with disinfectant after use.

**[0023]** Typically, a doctor treating a child having a neuropsychic disorder will prescribe a course of treatment, which would be supervised by a therapist, in which the child will be instructed to carry out exercises with a first set of massaging elements and then carry out exercises with a second, different set of massaging elements. In this manner, the set of massaging element is changeable during the treatment, rather than being fixed.

**[0024]** Use of colored massaging elements is particularly important because it provides a way for the patient, particularly a child, to receive reinforcement in the therapy. For example, if the therapist instructs the patient to remove a blue massaging element from the container, the patient receives immediate visual feedback on identifying a blue massaging element, even before removing the blue massaging element from the container.

**[0025]** The large number of stimulating factors (color, size, protrusions) associated with the apparatus described with reference to FIGS. 1 and 7 is particularly helpful in carrying out exercises with a child with delayed neuropsychic development. Such a child can use the apparatus to carry out an exercise involving searching for massaging elements of the same size, color and weight, and the child can also arrange the massaging elements in a pattern.

**[0026]** The compression spring 8 helps heighten the effectiveness of the point massage because the resilience of the spring 8 provides a more even distribution of force on the biologically active points on the uneven surface of the palm. Also, the elasticity of the massaging element due to the compression spring reduces the likelihood that the hard material of the massaging element will cause injury to a child's skin. The complex structure of the hand allows different parts of the skin on the palm to move differentially when the massaging element is manipulated in the hand, e.g. by squeezing or rolling. The elasticity of the massaging element

and the fact that the two hemispheres are connected together in a manner that allows relative rotation of the hemispheres allows relative movement of the hemispheres and reduces the possibility of discomfort or injury due to such differential movement.

**[0027]** Referring to FIGS. 9 and 10, it is desirable that the locations of the massaging protrusions on a spherical massaging element should be selected by a procedure that involves first inscribing a sphere with a polyhedron composed of regular polygons, such as hexagons and pentagons as shown in FIGS. 9 and 10, and then selecting as the locations of the massaging protrusions the vertices of the polygons and the points on the surface of the sphere that are radially outward of the centers of the polygons. By use of this procedure, it is ensured that the protrusion at the center of a polygon is equidistant from the protrusions at the vertices of the polygon.

**[0028]** Desirably, the container 1 has a narrow mouth so that a child who has one of the massaging elements grasped in his hand cannot withdraw his hand from the container until he has released the massaging element. Liquid may be placed in the container with the massaging elements for hydrotherapy or balneological therapy. It may be desirable to provide the container with a threaded lid or cover for sealing the container. In the event that the mouth of the container is wider, the patient may be able to insert both hands in the container for simultaneous exercise of the fingers of both hands, which may be advantageous for some treatments.

**[0029]** It will be appreciated that the invention is not restricted to the particular embodiment that has been described, and that variations may be made therein without departing from the scope of the invention as defined in the appended claims and equivalents thereof. Unless the context indicates otherwise, a reference in a claim to the number of instances of an element, be it a reference to one instance or more than one instance, requires at least the stated number of

~~instances of the element but is not intended to exclude from the scope of the claim a structure or method having more instances of that element than stated.~~

HISTORY OF THE INVENTION

The invention relates to medicine and provides an apparatus and a method for involuntary-reflectory therapeutic exercises.

The invention is designed for physiotherapy of movement disorders in patients with cerebral palsy.

The invention is also useful for other purposes, for example for physical therapy of disorders which are accompanied by dysfunction of the spinal congenital locomotive reflectory mechanism, i.e. conjugated (reciprocal) inhibition of the muscles-antagonists of the extremities and the functions associated therewith (tone, power, length, tension, balance and coordination of the muscles-antagonists of the extremities). In sport medicine, the invention can be used for physiologic reflectory "exercises" and dynamic training of spinal automatism of conjugated (reciprocal) inhibition of the muscles-antagonists of extremities in athletes.

A device for exercises comprising a container and massaging elements freely located therein. See the Inventor's Certificate of the USSR No 1,537,250 published on 23 January 1990. In this device, the massaging elements represent small indefinitely shaped particles produced of copper, zinc, or ebonite.

Operation principle thereof is as follows.

The arm is inserted into the container. A user grasps a transverse handle inside the container by the hand and then moves the arm in the shoulder joint with the apparatus mounted thereon (as in exercise with a dumb-bell).

This causes movement of the particles relative to the arm and to the container; the particles are contacted with the extremity surface and cause massage thereof.

The other known device for passive-active exercises is disclosed in the book by G.V.Dedyukhina et al/ "Logopedic massage and therapeutic exercises for children aged 3 to 5 years suffering from cerebral palsy", Moscow, "Gnom-Press" publishers, 1999, page 17.

This apparatus consists of a container and massaging elements freely disposed therein. The massaging elements are peas or kidney beans. By immersing extremity into the container with peas, which form a 6-8 cm thick layer, the exercises and the massage of fingers are performed.

Therapeutic effect of the known devices and methods is based on a combination of exercises with conventional soft (slightly stimulating) massage of extremity.

The drawback of this known principle of therapy is the absence of selective (differentiated) training of groups of the antagonist muscles of an extremity. In spastic cerebral palsy, lesion of the extremity antagonist muscles can be different because of muscular imbalance.

Motion disorders are manifested in the form of spastic pareses (voluntary movements are partially preserved, volume and power of motions are decreased) and spastic paralyses (voluntary movements are absent, only involuntary movements of extremities including reflectory ones are preserved).

For example, changes in flexor muscles of one extremity are characterized by shortening, elevation of muscular tone and tension and at the same time in extensor muscles the tone is lowered, they are distended and weakened. Therefore, extremities in patients with cerebral palsy are often in faulty position.

The known training facilities through usual active and passive gymnastic exercises train both - distended and shortened muscles belonging to a pair of antagonist muscles of a motion segment of one extremity. The training of both groups of muscles occurs with the same intensity.

Using such training, the difference in tone, tension,

length, and power between antagonist muscles is not eliminated, and it can even increase.

Preservation of muscular imbalance hampers correction of faulty spatial position of extremity and restoration of movement possibilities.

Selective training of antagonist muscles of one extremity is necessary for efficient therapy of motion disorders in cerebral palsy. Selective training is characterized by the following two processes taking place simultaneously:

1) active relaxation and distension of muscles being in the state of elevated tone and contracture

2) tonicizing and strengthening weakened, distended antagonist muscles

In cerebral palsy the spinal mechanism of conjugated (reciprocal) inhibition of antagonist muscles (discovered by C.S. Sherrington) during voluntary movement is also known to function incorrectly (i.e. it is pathologic one).

Contraction of a group of synergist muscles of extremity is accompanied by excessive relaxation of antagonist muscles. This makes the desired active targeted movement impossible (see L.O. Badalyan, "Pediatric cerebral paralyses", Kiev, "Zdorov'ye" publishers, 1988, page 32).

Furthermore, in complete spastic paralysis, voluntary movements of extremity are absent and therapy by active exercises is impossible.

Moreover, in passive gymnastic exercises the reflectory phase mechanism of conjugated inhibition of the extremity antagonist muscles is not trained, as it does not function. The existing gymnastic forms fail to restore normal functionality of the reciprocal inhibition automatism of antagonist muscles of extremities and to eliminate motion disorders accompanied by the disturbance thereof. It is explained by the fact that in their use in patients with motor disorders, this mechanism (reciprocal inhibition automatism) is not fully reproduced. The known techniques also have a low

efficiency in treating severe imbalance between antagonist muscle groups of one extremity.

A small size of massaging elements and consequently low safety during exploitation thereof is a significant drawback of the known devices. In treating patients younger than 6-7 years old, small parts may accidentally get into airways, ears, digestive tract.

The known devices do not allow for using water as an additional therapeutic factor (to carry out gymnastics in water to combine exercises with hydrotherapy).

Massaging elements in the form of peas and kidney beans quickly swell in water and lose their shape.

Therefore, in a liquid medium they cannot function effectively in accordance with their purpose. Furthermore, kidney beans can sprout in water.

The main drawback of the known methods is the fact that in their use there is no stimulation of sensory neuron endings of extremity capable of inducing reflectory response (involuntary motion response of the extremity) during voluntary or passive movement.

The known devices employ either active or passive movements that are insufficient for treating significant dysfunction of the conjugated inhibition automatism of antagonist muscles of extremities and eliminating muscular imbalance.

Stimulation of involuntary reflectory movements of extremities in patients with cerebral palsy, such that phase spinal automatism of the conjugated inhibition of antagonist muscles functions at its full value, is important for efficient restoration of reciprocal extremity innervations and selective reflectory movements of the extremity.

This invention is aimed at the development of a safe apparatus and method of involuntary-reflectory therapeutic exercises, which achieve a higher therapeutic effect compared to the conventional gymnastic exercises by: 1) stimulation of

involuntary reflectory extremity movements and 2) multiple reproductions through these movements of the physiological reflectory spinal mechanism of conjugated inhibition of antagonist muscles.

The indicated problem is resolved by the proposed invention.

The invention eliminates drawbacks of the known therapy principle. It operates based on a novel principle, which consists in using reciprocal inhibition of antagonist muscles in fast voluntary reflectory movement of extremity for a combined selective effect on weak and strong groups of antagonist muscles included into a motion segment of one extremity.

Normal function of the spinal automatism of reciprocal inhibition of antagonist muscles, which is reproducible in involuntary reflectory movement of extremity in patients with cerebral palsy, allows for conducting efficient reflectory training thereof and restoring voluntary movements.

The apparatus and method proposed here realize a novel form of gymnastics - the involuntary reflectory movements (which are natural and physiologically significant) are reproduced multiple times to achieve therapeutic effect. Using the novel form of gymnastics, a combined selective training of antagonist muscle groups of one extremity is achieved.

This novel form of gymnastics is also useful in a complete spastic paralysis.

Involuntary-reflectory gymnastics is based on functioning of the congenital unconditional spinal phase motion reflexes of extremities. Those reflexes cause fast responsive contractions of synergist muscles (a fast involuntary movement of extremity in a joint) and at the same time, they simultaneously cause phase reciprocal inhibition (relaxation) of the group of antagonist muscles.

## DISCLOSURE OF THE INVENTION

In accordance with the first aspect of the invention, a therapeutic apparatus is provided, which apparatus comprises a container with internal cavity and an inlet providing for access into the internal cavity of the container, as well as a plurality of massaging elements which are disposed in the container and are shaped into spherical bodies with projections manufactured in the form of stimulants of extremity sensory neuron endings of different modality.

At the same time, manufacturing form of the projections excludes skin damage during treatment.

The massaging elements are placed into the container in an amount that is sufficient to provide for contacting extremity with the projections of several massaging elements in movement inside the container.

In accordance with the second aspect of the invention, a method of therapy is provided which method includes:

(i) Providing a therapeutic apparatus, which apparatus comprises a container having an internal cavity and an inlet providing for access of extremity into the internal cavity of the container, as well as a plurality of massaging elements shaped as spherical bodies, which are freely placed into the internal cavity of the container and having projections on the external surface manufactured in the form of stimulants of extremity sensory neuron endings of different modality, for example pointed projections capable of pricking when contacting with extremity without damaging patient's skin; the massaging elements are placed into the container in an amount that is sufficient to provide the effect of the projections of several massaging elements on extremity;

(ii) Placement of patient's extremity into the above container and driving the massaging elements into motion, the projections of the massaging elements manufactured in the form of stimulants of extremity sensory neuron endings of different

modality multiply effecting external and/or internal surface of the extremity placed into the container.

In accordance with the third aspect of the invention, a massaging element comprising a spherical body and a plurality of projections disposed on external surface thereof is provided. The projections and the spherical body being manufactured as an integral piece of a solid material, for example, plastic and the projections being disposed in the projection points of apexes and centers of pentagons- and hexagons of a polyhedron (truncated icosahedron), conditionally inscribed into the body, on the spherical external surface of the massaging element.

## ESSENCE OF THE INVENTION

The present invention is based on a novel principle of physical therapy of motion disorders (a complete or partial immobility).

The essence of the invention is using the conjugated inhibition mechanism of antagonist muscles of extremity, which mechanism functions in a fast involuntary reflectory movement, in order to relax and eliminate elevated muscular tone, i.e. spastics. The essence of the invention also consists in restoration of voluntary movements through training the physiologic mechanism of the conjugated inhibition mechanism of antagonist muscles, which mechanism functions in reflectory movement of extremity.

Moving (passively or actively) in the container, an extremity contacts the projections manufactured in the form of stimulants of sensory neuron endings of extremity of different modality disposed on the external surface of the massaging elements.

This results in stimulation of sensory nervous receptors that is accompanied by involuntary reflectory motion reaction, i.e. jerking back the extremity.

Thus, during gymnastics session, voluntary and involuntary reflectory movements of diseased or normal extremity simultaneously arise.

In complete paralysis, passive and involuntary movements are possible.

Stimulation can be in the form of a puncture, applying shading action, a light stroke by tendon or osseous projection of the extremity (for example, styloid process) and electrostatic discharge.

Extremity in voluntary movement encounters the projections of the massaging elements.

Involuntary movements are caused by operation of unconditional phase spinal movement superficial and/or profound reflexes of extremities i.e. protective, tendon and/or periosteal reflexes.

Immediate reflectory jerking back of extremity (flexion or extension) occurs in patent.

The same reflex arises for example in jerking back of extremity from fire – it occurs unconsciously (involuntarily). Arising involuntary reflectory movements of extremities have a great physiologic importance because they result in sharp elevation of muscular tone and cause contraction of flexor muscles and simultaneous relaxation of extensor muscles of extremities (or vice versa). In this case, the reproduced spinal phase automatism of conjugated inhibition of antagonist muscles functions at its full value. Congenital automatism of conjugated inhibition of muscles consists of simultaneous concordant contraction and relaxation of antagonist muscles in movement of extremity in any of its joints.

This therapy principle distinguishes the present invention from devices and methods known from the prior art.

It must be noted that in central (cerebral) paralysis protective and tendon reflexes of extremities are preserved and even elevated (sensitivity is not disturbed).

In order to induce these reflexes in a patient with

cerebral palsy, no special efforts are required and only a light effect, like a puncture and/or a light stroke by a tendon of a respective muscle is sufficient.

Therefore, for a patient with central type extremity paralysis, the therapy in accordance with the invention principles does not cause difficulties.

When using the invention, the predetermined rehabilitation process is produced involuntarily, inevitably and non-intentionally when performing active exercises while an extremity is inside the container.

The invention is methodologically universal and allows for affecting many pathogenetic links of motion disorders including changes in normal spatial orientation of the skeletal-muscular system caused by muscular imbalance through the conjugated inhibition mechanism.

Multiple reproduction of the normal automatism of conjugated inhibition of antagonist muscles of extremities through stimulation of involuntary reflectory movements allows for conducting physiologic "gymnastics" (functional training) thereof.

The basic effect of the invention (stimulation of involuntary reflectory movements of extremities) provides for selective training of a weak and a strong muscle included into a pair of antagonist muscles of the extremity motion segment, for example the knee joint.

The weak, distended muscle in involuntary movement is actively reflectory contracted (trained) while the strengthened and spastic muscle is relaxed.

Mediated suppression of primitive pathologic tonic reflexes occurs through involuntary reflectory movements of extremity. In this case, one condition is necessary, namely imparting the correct direction to reflectory motion reaction. For example, if spasticity of extremity flexor muscles exists, then involuntary movements of extension type are multiply stimulated.

Or involuntary movements of flexion type are induced on the opposite extremity in crossed muscular groups.

In this case, the effect consists of activation of weakened distended extensor muscles and active reflectory relaxation of flexors.

The reflectory-reciprocal relaxation and tonization principle used in the present invention distinguishes the invention from the positional therapy method.

Therapy using orthopedic laying includes a direct static opposition to tonic reflexes (the K. and B. Bobath's concept). The novel concept of motion disorder therapy eliminates the main drawback of positioning, which is enhancing spasticity of muscles due to activation of tonic reflex to a slow distension. After the laying, the pathologic tone of these muscles is still more enhanced.

As involuntary reflectory movements are natural for the body, then stimulation thereof in order to suppress pathologic tonic reflexes and tension (muscular spasticity) is more physiological (so called dynamic principle).

Training of the physiologic congenital spinal automatism of conjugated inhibition of muscles allows for immediate restoration and improvement of the secondary motion automatisms, i.e. conditional-reflectory motion chains (complex professional motion acts).

Improving the functionality of the primary motion automatism at the spinal cord level results in mediated improvement of all kinds of athletic, working, and other movements, which are provided by phased fast reflexes, i.e. all movements wherein spinal automatism takes part.

The principal difference of the present invention is the fact that not secondary but primary (congenital) motion automatisms are trained, including training of professional athletes.

The conventional training directly affects mastering athletic motion habits and skills and multiple reproduction of

involuntary reflectory movements of extremities mediated by improvement of the primary congenital motion segmental automatism at the spinal cord level.

The present invention allows for performing gymnastics in a liquid medium.

Liquid medium facilitates movement of the massaging elements and of extremity surrounded by them. Solid spherical bodies with projections become apparently "weightless" during movement and uniformly fill the container volume.

Liquid medium also promotes muscular relaxation of extremities; it releases muscular tension and creates conditions for an easier reproduction of phase motion reflexes. In order to carry out therapy in accordance with the invention principles, all the patient body together with extremities or a major part of the body with an extremity may be placed into the container and just for this purpose, the presence of liquid is necessary.

The indicated disposition of the projection on the massaging element surface in accordance with the third aspect of the invention, allows for manufacturing the massaging element and the projections as an integral part from a solid material without deformation.

This particular design solution is the only one that achieves low manufacturing costs because manufacturing of the spherical body and the projections individually and then securing them with each other is a very labor-consuming process.

The invention achieves the possibility of using a solid material for manufacturing the body and the projections. That results in obtaining a solid massaging element with the projections being uniformly disposed along the surface of the ball and located at equal distance from each other.

The invention also allows for manufacturing the massaging element with a large amount of the projections as compared with the existing analogues and namely up to 92 pieces. Such number

of the projections on the massaging element surface allows for obtaining a rather small distance between apexes of the projections disposed at equal distance from each other, which distance equals the distance between sensory receptors of extremity (approximately 6 mm).

The spherically shaped massaging elements with the projections disposed on external surface were known before the instant invention. Namely, there are two known types of massaging elements with a spherical body and projections that are manufactured as an integral part (1,2):

1) A massaging element with the projections disposed at equal distance from each other along the ball surface manufactured from elastic-deformable (non-solid) materials (rubber) is known.

2) A massaging element manufactured from a solid material (plastic) with a small number of projections, which are disposed in small groups on diametrically opposite sphere poles, i.e. irregularly, is also known.

A solid material, which is not deformed in muscular effort or in contact with extremity surface at usual temperature, is needed for adequate stimulation of extremity sensory receptors. Such massaging elements (a solid rigid material, projections uniformly disposed at equal distance, a spherical body, and projections on external surface thereof manufactured as an integral part) could not be manufactured because of manufacturing difficulties.

When a solid massaging element exits the molding fitting during the manufacturing process, its projections get deformed. The present invention allows to overcome such manufacturing difficulties due to a special disposition of the projections on the massaging element surface and as a result producing a solid spherically shaped massaging element in which the projections and the body are manufactured as an integral part. The projections of a massaging element are disposed at equal distance from each other and uniformly fill all the external

surface of the spherical body. The invention allows for achieving a special disposition of longitudinal axes of all projections on the massaging element surface.

Spatial-angular relations between the projections and longitudinal axis of the body (junction plane of a molding form) in combination with using projections of predetermined height and a spherical body of predetermined diameter create conditions for a full value recovery of the article from a molding (technologic) fitting.

## BRIEF DESCRIPTION OF FIGURES

For a better understanding, the invention is clarified by figures and schemes wherein:

Fig. 1 is a schematic perspective view of the proposed therapeutic apparatus;

Fig. 2 is a perspective view of the spherical massaging element with pointed projections on the external surface;

Fig. 3 illustrates a sphere (a massaging element body) with a polyhedron (truncated icosahedron), inscribed therein;

Fig. 4 illustrates the massaging element disposed in the projection of apexes and centers of pentagons- and hexagons of a truncated icosahedron, conditionally inscribed into the sphere with pointed projections;

Fig. 5 illustrates operation of the apparatus and the method when massaging lower extremities;

Fig. 6 illustrates operation of the apparatus and the method when massaging upper extremities.

## DETAILED DESCRIPTION

Fig. 1 shows the container 1 with vertical walls and rectangular horizontal base (bottom). The container is manufactured of a rigid (hard) transparent, non-fragile, chemically stable water-repellent material such as

polypropylene; it has a lid and a cup 4 of the same or similar material. As an option, if the round container inlet is manufactured, then the lid 4 can be sutured in order to seal the container.

Inside the container 1 the massaging elements 2 manufactured in the form of spherical bodies having pointed projections 3 on external surface are placed.

The massaging elements are freely disposed in the container so that they are movable under pressure of extremity inside the container.

Lower surface (bottom) of the container can have depressions for storage of the massaging elements. Some of the massaging elements can be partially secured in the depressions, for example by tight fitting with possible removal thereof by effort of extremity.

Each massaging element 2 has external spherical surface. Pointed projections 3 are elevated over external spherical surface. As an option characterized, the projections are manufactured of different height (a preferable option) with height h from 3 to 5 mm. The projections mentioned uniformly fill all the external surface of the massaging element (see Fig.2) and they are located at equal distance from each other. Distance b between the projections located at equal distance from each other is 6 mm.

The massaging elements 2 can be continuous (manufactured as an integral part including a spherical body and the projections) of a hard material with hardness 5-95 according to Shore, preferably from 40 to 75.

These are mainly synthetic polymeric materials such as polystyrene, rubber, or wood.

The massaging elements can be manufactured of electrifiable material, i.e. material on the surface of which electrostatic charges can arise, for example ebonite.
The projections 2 must be relatively hard to adequately stimulate tactile (sensory) receptors of extremity.

Size of the massaging elements is chosen depending on age of patients. For patients aged 3 to 7 years, diameter of a smallest element can be 23 to 27 mm and diameter of a greatest one can be from 35 to 40 mm.

As a preferable option, the massaging elements are manufactured of different color.

As another option, the massaging elements are manufactured hollow and active elements are additionally placed inside.

The active elements may be magnets, audio reproducing elements, for example bells, aroma emitters.

The apparatus disclosed can be used for individual or group physical therapy.

Therapy is carried out in the following way.

Patient places extremity into the container 1 and actively moves therewith or the extremity is passively driven into motion being surrounded by spherical bodies 2 (Fig. 5, 6). In movement (for example passive, fluctuating active, or involuntary movement) the extremity encounters the pointed projections 3 which stimulate endings of the extremity sensory neurons of different modality by pricking; the massaging elements also moving.

The therapy according to the invention principles can also be achieved by driving into motion the container itself together with the massaging elements.

Thus, concurrently with active and passive gymnastics involuntary unconscious movements, i.e. jerking back extremity, are induced. As pricks are multiple, jerking off is reproduced many times. The opposite extremity, which is not subjected to the action of the projections, also jerks because of reflectory reactions in the crossed muscular groups. The jerks are very fast, sometimes unnoticeable for the eye. In some other cases, extremity jerks in the form of a chain motion reaction consisting of several phases. The jerks happen constantly during the exercises.

The massaging elements that are on the bottom and in cells do not allow patient to lean on extremity. Reflectory flexion of patient's extremity occurs when he tries to lean on it. Therefore, involuntary movements arise in a suspended state of extremity and during active movement.

The therapy can be carried out in a form of a play. In this case, a developing logic game (a puzzle) principle is reasonably used.

The presence of multi-color spherical bodies inside the container also stimulates active voluntary movements, i.e. desire to grasp bright balls, to displace them within the container.

Sequential grasping of the balls allows for performing spatial modeling extremity movements and renders a child with retarded development a great assistance in performing voluntary exercises. Laying the balls in accordance with a specimen (a puzzle) allows for programming motion chains (for example, to set a task of flexion type exercises). Transparency of the containers is of special importance to allow a physician to observe the actions of patients.

Manufacturing the container of a liquid impermeable material permits washing thereof in disinfecting solutions after use.

The container needs to have a narrow inlet to avoid removal of extremity from the container after grasping one or more massaging elements until patient releases the massaging elements grasped.

A liquid can be poured into the container with the massaging elements for hydrotherapy or balneal procedures. The liquid allows for modifying rehabilitation process and changing the character of responsive involuntary motion reaction.

This is achieved by using liquid of different composition and temperature (cold, hot or room temperature).

Equipping the container with a valve or a lid to close the container may be needed.

In case if the container inlet is broader, patient can insert two extremities therein for simultaneous exercises, or to place all the body or a portion of the body with extremity that in some cases can be desirable.

Referring to Fig. 3 and 4, the projections on external surface of the spherical massaging element and body thereof are to be manufactured as an integral unit of a hard material, for example plastic.

A hard body and projections are needed to adequately stimulate sensory receptors of extremity and to enhance efficiency of the therapy.

In order to manufacture the massaging element as indicated above without spoilage, the projections on external surface of the massaging element need to be located in the projection points of apexes and centers of pentagons and hexagons of a polyhedron (truncated icosahedron), conditionally inscribed into the body, on the spherical external surface of the massaging element.

The article formation process without deformation in the indicated disposition of the projections is controlled by selection of predetermined parameters of projection height and distances between them, which must correspond to external diameter of the spherical body.

For example, to avoid spoilage in external diameter of the spherical body 30 mm, height of the projections must be within the range of 3 to 8 mm, preferably from 3 to 5 mm, distance between the projection apexes being 4 to 7 mm preferably 6 mm. Furthermore, such massaging element will have uniform disposition of the projections along entire surface, which are disposed at equal distance from each other.

Manufacturing the spherical body of the massaging element with the indicated above disposition of the projections on the external surface of two hemispheres and then mutual attachment thereof still enhances technological effectiveness of manufacture thereof.

As can be seen from the disclosure, by using items proposed above and actions over them, a definite effect is achieved. Some changes can be introduced into the construction described above without departing from the spirit and purpose of the invention. Everything comprised in the specification above and shown in the accompanying drawings is supposed to be interpreted as illustrations and not in the sense of limitation.

It is welcomed if the invention will not be limited by some particular option of the construction described above. Variations are possible without breach of the general disclosure of the invention as is indicated in the appended claims.

If the context does not show otherwise, number of claim should be indicated irrespectively of the fact whether one or more claims are referenced.

However, structure or method having more examples than indicated in claim need not be deleted from the claim.